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(54) **Thermal processing system**

(57) A method and a thermal processor (20) for heat development of an imaging element (5) include an oven (30) having heating sources (51, 52) and means (53, 54) for applying hot air to both sides (6, 7) of the imaging element. Flows (41, 42) of hot air are dimensioned such that the imaging element is supported by the flows when passing through the oven. Transport of the imaging element through the processor (20) is carried out by an entrance unit (80) and optionally by an exit unit (90), but in any case without any mechanical contact within the oven (30). In further embodiments, the heating sources have substantially identical operational characteristics, and the means for applying hot air to both sides of the imaging element generate substantially equal flows at substantially equal air temperatures.

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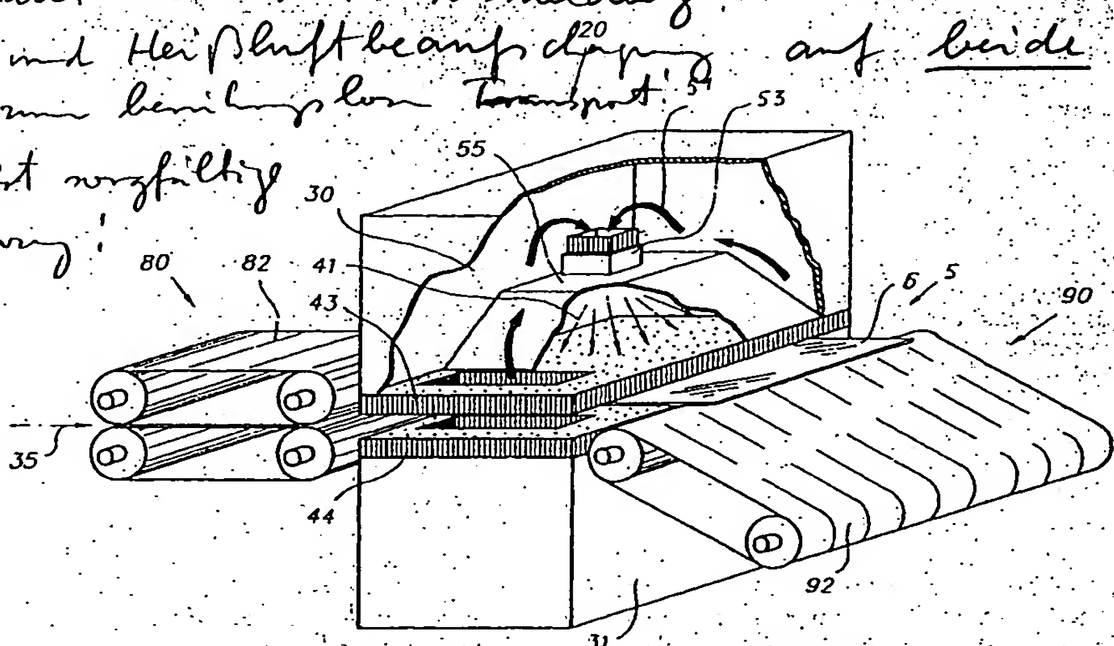


FIG. 2

EP 0 864 944 A1



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Description

## FIELD OF THE INVENTION.

The present invention relates to an apparatus and a method for thermal processing of a photographic material. More specifically the invention is related to thermal processing of thermographic material, in particular a photothermographic material, also referred to as "imaging element".

## BACKGROUND OF THE INVENTION

Thermally processable silver-containing materials for producing images by means of exposing followed by heating are referred to as thermographic materials and are generally known. For example: "Dry Silver ®" materials from Minnesota Mining and Manufacturing Company. A typical composition of such thermographically imaging elements includes photosensitive silver halide in combination with an oxidation-reduction combination of, for example, an organic silver salt and a reducing agent therefor. These combinations are described, for example, in US Patent No. 3,457,075 (Morgan) and in "Handbook of Imaging Science", D.A. Morgan, ed. A.R. Diamond, published by Marcel Dekker, 1991, page 43.

An overview of thermographic systems is given in the book "Imaging Systems" by Kurt I. Jacobson and Ralph E. Jacobson, The Focal Press, London and New York, 1976, in chapter V under the title "Systems based on unconventional processing" and in chapter VII under the title "7.2 Photothermography".

Photothermographic imaging elements are typically processed by imagewise exposure, for example in contact with an original or after electronic image processing with the aid of a laser, as a result of which a latent image is formed on the silver halide.

Further information on such imagewise exposures can be found in Patent Application EP-A-96.201.530.1 (with priority date on 1996.06.01) of Agfa-Gevaert.

In a subsequent heating step the latent image formed exerts a catalytic effect on the oxidation-reduction reaction between the reducing agent and the non-photosensitive organic silver salt, usually silver behenate, as a result of which a visible density is formed at the exposed locations. The processing conditions are defined by the choice of the non-photosensitive organic silver salt and a reducing agent therefor. For example, the processing temperature is around 120°C, for ten seconds.

Further information on thermographic materials can be found, for example, in said Patent Application EP-A-96.201.530.1.

Practical problems with the processing of photothermographic imaging elements often result from the fact that the density formed depends on the amount of heat supplied, or from the fact that during processing a mechanical contact smears the image.

Further examples of such disturbing facts comprise particles or dust which are offset from the imaging element to the environment (or vice versa), either by friction, or by adhesion; and image artefacts as e.g. pinholes caused by dustparticles.

## OBJECTS OF THE INVENTION

It is a first object of the present invention to provide a thermal processor and a method for processing of a photothermographic material, wherein smearing of the image during processing is avoided.

It is an other object of the present invention to provide a thermal processor and a method for uniform processing of a photothermographic material, wherein all locations of each side of said photothermographic material obtain substantially equal processing temperatures.

Further objectives and advantages will become clear from the description following hereinafter.

## SUMMARY OF THE INVENTION

The above mentioned objects are realised by the embodiments having the specific features defined in the independent claims of the present application. Specific features for preferred embodiments of the invention are disclosed in the dependent claims.

Further advantages and embodiments of the present invention will become apparent from the following description and drawings.

## BRIEF DESCRIPTION OF THE INVENTION

The invention will be described hereinafter with reference to the accompanying drawings, which are not intended to restrict the scope of protection applied for by the present application.

Herein:

Fig. 1 is a longitudinal view of a thermal recording system comprising a thermal processor according to the present invention;
Fig. 2 shows a perspective view of a thermal processor according to the present invention;
Fig. 3 is a transversal section through a preferred embodiment of an oven according to the present invention;
Fig. 4 is a transversal section through another preferred embodiment of an oven according to the present invention;
Fig. 5 is a longitudinal view of an oven comprising flows of hot air according to the present invention;
Fig. 6 shows several embodiments of air distribution means suitable for use in the present invention;
Fig. 7 shows a preferred embodiment of an imagesetter with an integrated vertical processor according to the present invention;

Fig. 8 shows another preferred embodiment of an imagesetter with an integrated vertical processor according to the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

As an aid to a better understanding of the specification and the claims to follow, some specific terms are explained first.

The terms "imaging element", "(photo-)thermographic material" or "sheet" as used further in the present specification stand for a sheet of opaque paper, a white bond paper, a resin coated paper, a transparent film, a plastic, a laminate of both, an adhesive label, a printing plate or a web onto which the image is received. This sheet may be an end-product as such, but it may also form an intermediate step in a reproduction process. For example, it may be used, after a suitable treatment, as a so-called transfer element, e.g. as a printing plate for printing images by planographic printing techniques onto a final support.

The term "printing" stands for a printer which creates an output printing image by laying out the image in a series of scan lines, each line having a given number of pixels or picture-elements per inch. An exposure station for exposing the recording may comprise a Cathode Ray Tube (CRT), or more preferably a laser with a rotating mirror block, an array with Light Emitting Diodes (LED's), a uniform light source and a plurality of individually controllable light valves, an arrangement with deformable micro-mirror devices (DMD's), etc. Examples of lasers that can be used in connection with the present invention are e.g. HeNe lasers, Argon ion lasers, semiconductor lasers, YAG lasers e.g. Nd-YAG lasers etc. However, the term printing encompasses also an apparatus in which the exposure of the recording member occurs by the optical projection of an integral image, such as in a copier.

Referring to Fig. 1, an apparatus 1 embodying the present invention includes an exposing part or imager 10 and a processing part or processor 20, disposed side by side. Specifically, in the imager 10, an imaging element 5, e.g. a photographic film or paper in the form of a roll 15, is placed in a magazine (e.g. with a 60 meter supply) and positioned at an exposure stage, comprising a light source 12. The imaging element 5 exposed imagewise is separated into individual images with a cutter (not shown in this drawing), and is fed by an entrance unit 80 (comprising e.g. a belt mechanism 82) into an oven 30. The photographic material thus developed in processor 20 is then ejected by an exit unit 90 (comprising e.g. another belt mechanism 92) as photographic print 95 into a print outlet 97. Numerals 6 and 7 respectively refer to the first side and the second side of the imaging element 5. Numerals 2 and 3 respectively refer to a drive unit 2 (comprising e.g. an electromotor and a transmission), and to a control unit 3 (comprising e.g. electronic circuits for drive control, and for heat control). Numeral 50 refers to a heating unit (comprising e.g. electrical heating sources and thermal sensors).

Before proceeding with the detailed description, reference is made to several drawings (wherein like numerals refer to like parts), of which Fig. 2 shows a perspective view of a thermal processor according to the present invention; Fig. 3 is a transversal section through a preferred embodiment of an oven according to the present invention; Fig. 4 is a transversal section through another preferred embodiment of an oven according to the present invention; and, Fig. 5 is a longitudinal view of an oven comprising flows of hot air according to the present invention.

In order to obtain that during processing all locations of each side of the imaging element 5 are heated to substantially equal temperatures, a hot air oven 30 is applied. Said hot air fulfils two different functions, namely (i) an air-cushion function which provides a contactless moving of the imaging element, and (ii) a heating function, homogeneously heating at least one side of the imaging element.

In general, oven 30 includes a rectangular frame or housing 31 in order to support other components. Such components comprise means for applying hot air to the imaging element (e.g. blowers or fans), heating sources, power controllers, temperature controllers (or thermostats), speed controllers, plates, bolts, etc.

As an oven 30 according to the present invention comprises means for moving the imaging element, these may be carried out by different mechanisms (not explicitly shown for sake of clarity; only schematically indicated by refs. 47, 48 in Fig. 5). For example: gravity as such in case of a vertical path, downwards oriented, of the sheet; a belt; a clamp mechanism gripping the sheet on non-imaged borders, or another transporting or moving means comprising means for keeping a fixed orientation of the sheet and means for keeping contact with an edge of the sheet, etc.

Conveying the imaging element in the processor 20 preferably is not done with a conventional transport, since the transport would make contact with the imaging element and possibly could smear the image, but is done in a mechanically contactless manner. As can be seen in figures 2-5, heat development is done nearly contactless (meaning that substantially no rollers, nor plates, nor sensors are in contact with the imaging element) and a controlled stream of hot air is conveyed at both sides (front-side and rearside)of the imaging element, so that the imaging element is supported by the air flow. Per consequence of this contactless heating, no particles nor dust are offset from the imaging element 5 to the environment, and vice versa, neither by friction, nor by adhesion. Per further advantageous consequence of this contactless and homogenous heating, no image artefacts (e.g. no pinholes) are generated.

As mentioned before, oven 30 also comprises means for simultaneously heating the sheet, while moving said sheet, by applying hot air, which also may be

carried out by different mechanisms. One example of an air distribution means comprises a set of two perforated plates, localised at both sides of the sheet on the path followed by the sheet, preferably made of thermally conductive material (such as many metals and alloys). Many other examples of air distribution means will be discussed later on (cf. Fig. 6). Preferably, housing 31 has a sheet material inlet and a sheet material outlet so positioned as to define a predetermined sheet material path 35 through the processor.

It may be clear from the foregoing, that a first embodiment of a thermal processor 20 for heat development of an imaging element 5 5 according to the present invention comprises an oven 30, heating sources 51-52, and means 53-54 for applying hot air to both sides 6, 7 of said imaging element, wherein flows 41, 42 of hot air are dimensioned such that said imaging element 5 is supported when passing through said oven 30.

In other embodiments of the present invention (see Figs. 2-4), the processor has a housing 31 for the oven 30 which further comprises air distribution means 43, 44 consisting of grooved, or perforated or sintered plates).

Fig. 6 shows several embodiments of air distribution means suitable for use in the present invention, all air distribution means comprising openings. The numerals (from 43a to 44h) for these embodiments consist of two parts: a prefix (referring to the position of the air distribution means) and a suffix (referring to the pattern of the openings in the air distribution means). So, prefix 43 refers to one distribution means, e.g. the upper distribution means in a horizontal oven; whereas prefix 44 refers to another distribution means, e.g. the lower distribution means in a horizontal oven. Suffixes (from a to h) refers to specific patterns or geometries of the openings in the air distribution means.

Numerals 43a and 43b refer to sintered plates with a thickness (cf. Z-axis) between 1 and 10 mm, made of ceramic, graphite, or bronze. Numerals 43b and 44b refer to perforated plates; in one of the experiments, these perforations had diameters between 0,5 and 3 mm, e.g. about 1,5 mm, at centre distances about 7 mm and staggered under an angle of about 84,5 ° with the X-axis. Numerals 43c and 44c refer to plates continuously grooved in parallel to the width direction Y; numerals 43f and 44f refer to plates discontinuously grooved in parallel to the width direction Y. Numerals 43d and 44d refer to plates grooved arcuately, either convex, either concave. Numerals 43e and 44e refer to plates with V-shaped openings; numerals 43g, 44g and 43h, 44h refer to some modifications on these V-shaped openings.

As shown in Figs. 3 & 4, air from a blower 53, 54 is passed over heating sources 51, 52, which are preferably electrically energised. Heating sources 51, 52 can be placed before the blowers 53, 54 (as illustrated in Fig. 3), or they can be placed downstream of the blowers 53, 54 (as illustrated in Fig. 4). On passing in contact with the heating sources, a heat exchange takes place to raise the air temperature to a predetermined setpoint of a thermostat (not shown in the drawings). The air further passes a cavity or pression chamber 55, 56 and flows through openings 45, 46 in plates 43, 44 to pass in contact with the imaging element 5, and then returns for recycling. By means of adjustment bolts (not shown), the plates 43, 44 may be spaced accurately at any desired distance above the predetermined transport path 35.

The thermal efficiency of this oven 30 is very high because of two reasons: (i) in order to prevent heat loss from the housing to the ambient surroundings, thermal isolation 39 is applied over the housing; (ii) once operating, the air is recirculated such that losses or leakages are kept to a minimum.

In summary, a preferred embodiment of an oven 30 for processing an image on an imaging element 5 comprises means for moving said imaging element along a predetermined path 35 through said oven and means for applying hot air to both sides of said imaging element.

In an oven according to the present invention, the temperature of the air flows 41, 42 may be kept substantially constant at a predetermined value by introducing suitable temperature controllers, such as a thermistor or a bimetal (not shown for sake of clarity). Preferably, a temperature detecting element is provided near the surface of the imaging element. More preferably, a contactless temperature sensor is used for measuring the temperature of the imaging element 5.

Even more than one temperature sensor may be used, preferably situated on different positions relative to the imaging element. For example, one temperature sensor can observe the image zone on the imaging element and another temperature sensor can observe outside the image zone.

In order to get a complete temperature control system, the thermal sensor or temperature controller is connected to a thermostatic control circuit (not shown). The temperature of each air flow 41, 42 is kept substantially constant at a predetermined value T1, T2, the temperature deviation over time being less than 20 K, preferably less than 5 K, more preferably less than 0,5 K, and most preferably less than 0,1 K.

As the imaging element 5 leaves the oven 30, it may be taken by suitable means 90, such as a belt system 92 or a vacuum-belt system, for further transport to a print outlet tray 97 for subsequent removal.

In a further preferred embodiment, the oven 30 is arranged for movement of said imaging element along a path 35 being substantially straight or rectilinear, meaning that path 35 has no radius of curvature smaller than 1000 mm.

In a particular method according to the present invention, the path 35 of the imaging element 5 is substantially horizontal. By the wording substantially horizontal is meant a path within a range of [-5°, +5°] to a horizontal path.

In another particular method according to the

present invention, the path 35 of the imaging element 5 is substantially vertical. By the wording substantially vertical is meant a path within a range of [-5°, +5°] to a vertical path.

Some advantages of a horizontal path comprise: (i) if the sheets in an input tray and in an output tray lay in a horizontal position, said sheet can follow a rectilinear path, which is very advantageous for a high reliability of the transport system (e.g. a very low risk for jam and for wrinkles); (ii) the height of the apparatus can be rather low, which may be extra comfortable for the operator.

Some advantages of a vertical path comprise: (i) the operations acting on the sheet may be carried out with a high symmetry, because there is no preferential influence from heat or gravity as it regards both sides of the sheet; (ii) the floor-space necessitated for the apparatus can be rather small.

Yet any other orientation of the path 35 of the imaging element 5 may be advantageous and is included within the scope of the present invention. At the beginning of the detailed description, in reference to Fig. 1, a thermal recording system is disclosed comprising a horizontally oriented thermal processor according to the present invention. Now, reference is made to Fig. 7, which is a cross section of a preferred embodiment of an imagesetter with an integrated, vertically oriented, thermal processor according to the present invention. With reference to Fig. 7, the present application discloses an apparatus 1 for automatically exposing and processing an imaging element, comprising (i) an exposing part in which said imaging element is imagewise exposed, and (ii) a processing part in which said imaging element is thermally processed, wherein said exposed imaging element is fed automatically from said exposing part into said processing part and wherein said processing is carried out along a substantially vertical path.

Yet, depending on the system and on the specific layout, some parts of the processing path can be horizontal. In order to illustrate this statement, reference is made to Fig. 8 which gives a cross section of another preferred embodiment of an imagesetter with an integrated vertical processor according to the present invention. Herein, the imaging elements are transported along a composite path including a vertical portion, an arcuate portion (in entrance unit 80) and a vertical portion (in oven 80 and in exit unit 90). Moreover, it is immaterial whether the thermal processor receives imaging elements from above or from below.

It is preferred that the outlet of the recording apparatus 1 is at the upper end so that an operator who feeds imaging elements to the system also can monitor or collect the imaged elements issuing from the apparatus 1. Thus, in a further preferred embodiment of the present invention (see Figs. 7 & 8), the apparatus 1 further comprises "outputting" means for laying down the exposed and processed imaging element in an exit tray at the operator's side of the apparatus.

In a particular preferred embodiment of the present invention, the apparatus 1 further comprises "turning" means for laying down the exposed and processed imaging element in an exit tray at the operator's side of the apparatus either face up, either face down. In view of convenient handling, apparatus 1 may be placed on a raised platform 99.

For people skilled in the art, it may be evident that in a preferred embodiment of the present invention, the recording apparatus 1 further comprises driving means (not shown for sake of clarity) for catching the imaging element and guiding said imaging element first through the exposing part, and then through the processing part.

A further embodiment of a thermal processor 20 for heat development of an imaging element 5 comprises an entrance unit 80 having means 82 for entering said imaging element into the thermal processor, an oven 30, an exit unit 90 having means 92 for transporting said imaging element out of the thermal processor, wherein said oven 30 comprises heating sources 51, 52 and means for applying hot air to both sides 6, 7 of said imaging element.

In a further embodiment the entrance unit 80 comprises means 82 for entering said imaging element into the thermal processor having a belt or a vacuum belt.

In a further embodiment the exit unit 90 comprises means 92 for transporting said imaging element out of the thermal processor having a belt or a vacuum-belt.

In a further embodiment, the flows 41, 42 of hot air are different, so that the pressure of the upper air flow 41 is somewhat less than the pressure of the other air flow 42, the difference in pressure being preferably less than 0,5 kg/ $cm^2$.

In a still further preferred embodiment of the present invention, the processor further comprises means for moving said imaging element via said predetermined path 35 through said processor.

In a still further preferred embodiment of the present invention, the oven also comprises a heating unit (schematically indicated by referral 50 in Fig. 1) having electrical resistance heaters, a temperature sensor, and a heat controller.

In a still further preferred embodiment of the present invention, the housing further comprises heaters (e.g. thermofoil heaters) disposed around the housing, and an isothermal guard (indicated by ref 39 in Fig. 4).

In a still further preferred embodiment of the present invention, the spacing between said air distribution means 43-44 and said imaging material 5 is in the range of 2 to 20 mm, preferably between 5 and 10 mm.

In a still further preferred embodiment of the present invention, the housing comprises a hinge in order to open or close at least one part of the housing. If a cover of the housing is pivotal along an edge, or alternatively is moveable, it allows the operator access to the internal parts of the system. Optionally latching means comprise a catch on the cover and complementary catch engaging means, which may be operated by a solenoid to control the engagement.

In many applications, e.g. in high quality printing and especially if both sides 6, 7 of an imaging element 5 are coated with chemistry (e.g. a sensitive layer at one side and a coating on the other side 7), it has to be made sure that both sides of the imaging element experience substantially the same "heating history", referring to the temperature-trajectory. Therefore, a high degree of operational symmetry in both air flows 41, 42 is preferable. Moreover, a separate power-control controls each heating source such that the air flows 41, 42 have substantially equal air temperatures T1, T2, the temperature deviation between said air flows being less than 20 K, preferably less than 5 K, even more preferably less than 0,5 K.

By the terms equal flows is meant that the flow rate of air (quantified in e.g. $m^3/h$) at one side (see numeral 6) of the imaging element 5 does not deviate more than 10 %, and preferably not more than 2 % from the flow rate of air (quantified in e.g. $m^3/h$) at the other side (see numeral 7) of the imaging element 5

Therefore, a further embodiment of thermal processor 20 for heat development of an imaging element 5 according to the present invention, comprises an oven 30, said oven having heating sources 51, 52, and means for applying hot air to both sides 6, 7 of said imaging element, wherein said flows 41, 42 of hot air are dimensioned such that said imaging element 5 is supported by said air flows when passing through said oven 30, and wherein said heating sources 51, 52 have substantially identical operational characteristics (meaning that the powers P1, P2 of both heating sources do not deviate more than 10 % from each other, preferably not more than 2 %) and said means for applying hot air to both sides 6, 7 of said imaging element 5 generate substantially equal flows 41, 42 at substantially equal air temperatures.

According to a preferred embodiment, the powers P1, P2 of both heating sources are in the range of 500 to 3500 Watt, more preferably from 1000 to 3000 Watt.

The most preferred embodiment of a thermal processor 20 for heat development of an imaging element 5 according to the present invention comprises an entrance unit 80 having means 82 for entering said imaging element 5 into the thermal processor, and an exit unit 90 having means 92 for transporting said imaging element out of the thermal processor, and an oven 30, said oven having heating sources 51, 52, and means for applying air 53, 54 and means for distributing 43, 44 flows of hot air 41, 42 to both sides 6, 7 of said imaging element, wherein said flows 41, 42 of hot air are dimensioned such that said imaging element 5 when passing through said oven 30 is supported by said flows of hot air.

According to another aspect of the present invention, a recording apparatus 1 for photothermography, comprises a thermal processor 20 as disclosed hereabove and which is coupled to an apparatus for exposing the imaging element (also called imager or imagesetter 10).

In further preferred embodiments of the present invention, said imaging element 5 comprises a photohermographic material.

Typical support materials include film, paper, polyester, aluminium and glass.

According to another aspect of the present invention, aside from the above described embodiments of an oven 30, also disclosed are several methods for heat developing an imaging element according to the present invention. These methods can also be applied to support imaging elements which are not separate sheets in the strict meaning, but which are in web-form.

A first preferred method uses an oven 30 according to any one of the above-mentioned descriptions, which all have (at least) in common that the flows 41, 42 of hot air are dimensioned such that the imaging element 5 is supported when passing through said oven.

According to the present invention, a method for heat developing an imaging element 5, comprises the steps of (i) moving said imaging element along a predetermined path 35 through an oven 30, (ii) applying hot air 41, 42 to both sides 6, 7 of said imaging element, characterised in that said hot air 41 applied to one side 6 of said imaging element 5 exerts substantially equal forces to said imaging element as said hot air 42 applied to said other side 7 of said imaging element 5. Herein, the terms substantially equal forces mean that said forces (e.g. indicated in N) deviate less than 10%, and preferably less than 5%, from each other.

As to a balance of forces exerted to said imaging element, in case of a path 35 which would be not vertical (e.g. a horizontal or an inclined path), influences of gravity of the imaging element 5 also have to be taken into account. This especially is true if imaging elements are applied having a relative higher weight (e.g. indicated in kg).

A further preferred method for heat developing an imaging element 5 comprises the steps of (i) moving said imaging element along a predetermined path through an oven, (ii) applying hot air to both sides of said imaging element, characterised in that said hot air is heated by heating sources with substantially identical operational characteristics, in that said hot air is enforced in substantially equal flows to both sides of said imaging element and in that said flows of hot air are heated to substantially equal air temperatures.

In a still further method for heat developing an imaging element 5 in a thermal processor comprises the steps of (i) entering said processor via an entrance unit 80; (ii) moving said imaging element along a predetermined path through an oven 30, (iii) applying hot air to both sides of said imaging element, (iv) transporting said imaging element through an exit unit 90, wherein said hot air is heated by heating sources with substantially identical operational characteristics, said hot air is enforced in substantially equal flows to both sides of said imaging element and said flows of hot air are heated to

substantially equal air temperatures.

In a still further preferred embodiment of the present invention, said equal air temperatures are in the range from 80 to 200 °C, preferably between 90 to 130 °C, more preferably between 100 and 120 °C, even more preferably between 110 °C and 118 °C.

A further preferred method comprises a preheating step, preferably acting symmetrically on both sides 6 and 7 of the imaging element 5. By doing so, some mechanical characteristics of the sheets (e.g. moisture contents or differences thereto) may be equalised, so that a still lower jam rate and even a better quality may be obtained.

In a still further preferred embodiment of the present invention, said imaging element 5 advances at a (linear) speed between 10 and 250 cm/min, preferably between 25 and 150 cm/min, and more preferably between 50 and 125 cm/min.

Depending on the exact kind of imaging element and on the processing speed, the processing time is between 2 and 60 seconds, more preferably between 5 and 25 seconds.

In a still further preferred embodiment of the present invention, each of said air flows has a flow rate comprised between 5 and 500 $m^3/h$.

In a further preferred embodiment of the present invention, each of said air flows has a velocity comprised between 0,1 and 15 m/sec, measured downstream of the openings 45, 46 of the air distribution means 43, 44.

In a still further preferred embodiment of the present invention, said flows comprise recirculating air for a high volume percentage (e.g. 70-80%) while taking in fresh air for the remaining volume percentage (e.g. 30-20 %).

In a still further preferred embodiment of the present invention, said developing is carried out after said imaging element 5 has been imagewise exposed to light

In a still further preferred embodiment of the present invention, an emulsion side of said sheet material is directed upwards (along the Z-axis).

In a still further preferred embodiment of the present invention, the heating sources are activated as the imaging element is exposed in the imager.

As might be clear to the people skilled in the art, some other difficulties are to be solved. Amongst them: (i) transporting the imaging element from the imager towards the processor without damaging the images; (ii) providing a specific processing speed required to obtain stable image quality on a wide variety of base print materials, whereas the imager usually only has a very limited number of discrete imaging speeds; (iii) moreover, the heating and imaging speeds can hardly be made exactly equal, thereby necessitating a way to decouple both speeds.

In a method according to the present invention, these just mentioned difficulties are solved by providing a buffering device between the imaging station and the heating station. This buffer can handle differences in speed, isolate vibrations and/or thermal influences from the imaging station to the heating station (and vice versa), etc. Further, it may be desirable to adjust the processing speed independently from the image processing speed, for obtaining optimum results. The length of the buffer station needs to be sufficiently large for receiving the largest sheet size to be processed in the apparatus.

In a preferred embodiment of the present invention, said imaging element is in sheet form. In another preferred embodiment of the present invention, said imaging element is in web form.

The most preferred embodiment of a method for heat developing an imaging element (5) according to the present invention, comprises the steps of:

- entering said imaging element into said processor via an entrance unit (80),
- moving said imaging element along a predetermined path (35) through an oven (30), and applying hot air to both sides (6, 7) of said imaging element (5), wherein said hot air is heated by heating sources with substantially identical operational characteristics, wherein said hot air is enforced in substantially equal flows (41, 42) to both sides of said imaging element and wherein said flows of hot air are heated to substantially equal air temperatures, and
- transporting said imaging element out of the processor by means of an exit unit (90).

In an experiment, several sheets (with dimensions of 14" x 17") of a photothermographic material as described in application EP-A-96.201.530.1 first have been imaged on an imager with a laserdiode of 150 mW at a wavelength of 870 nm. One set of imaged sheets has been thermally developed on a drum processor as disclosed in patent application BE-097.00883 (filed on 5 November 1997; in the name of Agfa-Gevaert N.V.); another set of imaged sheets has been thermally developed in a processor according to the present invention. Inspection of the resulting density on thus processed films revealed that the first set of films showed some pinholes, caused by dustparticles which were on the film when contacting the heated drum. In the second set of films, no pinholes were perceived. This indicates that the actual thermal processor guarantees a better thermal processing for the imaging element.

Having described in detail preferred embodiments of the current invention, it will now be apparent to those skilled in the art that numerous modifications can be made therein without departing from the scope of the invention as defined in the appending claims.

## APPLICABILITY

As will be understood, the oven 30 is adapted for thermal processing individual cut sheets as well as for thermal processing continuous webs.

Application of a processor or a method according

to the present invention is not restricted to photothermography, but many other fields are also conceivable, such as conventional silver halide photography (in the context of drying wet-processed photographic materials), medical films (also in the context of drying wet-processed materials), micrography (see below), printed matter (cf. drying of one or more inks), printing plates (cf. drying, baking), ink jet and toner jet (see below), etc.

As to micrography, processes are known for the production of vesicular images, comprising the steps of (i) imagewise exposing, and of (ii) uniform heating. More in particular, two kinds of vesicular processes are known, which are based respectively on the decomposition of diazonium salts by ultraviolet exposure, or on the decomposition of peroxide compounds at silver nuclei formed on exposure by light of a silver halide material. In the second process, the image is rendered visible e.g. by uniform heat development as follows: upon heating the exposed imaging element, the gas bubbles produced by decomposition expand and a bubble image is formed. Since these bubbles scatter the light imagewise, the areas containing them appear dark with transmitted light but appear light on a dark background when viewed by reflected light. More information on vesicular microfilm can be found in e.g. USP-4,065,312 (in the name of Agfa-Gevaert) and in USP 4,440,494 (in the name of Bell & Howell Cy).

In order to obtain a lithographic printing plate based on a photothermographic material, reference can be made to EP-A-97.202.396.4 (in the name of Agfa-Gevaert N.V.). Herein, after image-wise or information-wise exposing to actinic light a recording material, developing a substantially light insensitive organic heavy-metal salt is carried out by exposing the recording material to a temperature of at least 65°C and at most 5°C below the glass-transition-temperature Tg of the thermoplastic particles, hereby forming a heavy-metal image. It is to be noted that said photothermographic material can yield waterless offset printing plates as well as printing plates which need water or a fountain solution for printing.

In "ink jet" or in "toner jet" printing systems, an ink fluid or a toner is usually first sprayed in an imagewise manner onto a receiving material, followed by uniform heating. More information on ink jet systems can be found in, for example in EP 0 641 670 and in EP 0 691 211 (both in the name of Agfa-Gevaert). More information on toner jet systems can be found for example in EP-0 706 094 A1 (in the name of Agfa-Gevaert). In such systems, uniform heating can be carried out, if required, in accordance with the present invention.

Reference can also be made to EP-A-97.204.015.8 (filed on 1997.12.18, in the name of Agfa-Gevaert N.V.), which relates to providing lithographic printing plates by using ink-jet printing. This makes it possible to produce the lithographic plates directly from digital data output from computers, or the like, without using any films. In a first step, microdots of a curable hydrophobic ink are sprayed onto a lithographic base in a predetermined pattern as the plate passes through the printer. In a following step, curing the sprayed droplets of the ink upon the lithographic base is carried e.g. by heat, preferably in accordance with the present invention.

**Parts list**

| | |
|---|---|
| 1 | recording apparatus |
| 2 | drive unit |
| 3 | control unit |
| 5 | imaging element |
| 6 | first side of the imaging element |
| 7 | second side of the imaging element |
| 10 | imager |
| 12 | light source |
| 15 | supply cassettte |
| 20 | thermal processor |
| 30 | oven |
| 31 | housing |
| 35 | path |
| 39 | isothermal isolation |
| 41, 42 | air flows |
| 43, 44 | air distribution means |
| 45, 46 | openings |
| 47, 48 | means for moving |
| 50 | heating unit |
| 51, 52 | heating sources |
| 53, 54 | blowers, fans |
| 55, 56 | pressure chambers |
| 80 | entrance unit |
| 82 | belt |
| 90 | exit unit |
| 92 | belt |
| 95 | photographic print |
| 97 | print outlet (tray) |
| 99 | platform |
| X | transportation direction |
| -X | reverse direction |
| Y | transversal direction |
| Z | vertical direction |

**Claims**

1. A thermal processor (20) for heat development of an imaging element (5) comprising an oven (30), said oven having heating sources (51, 52), and means for applying flows (41, 42) of hot air to both sides (6, 7) of said imaging element, wherein said flows (41, 42) of hot air are dimensioned such that said imaging element (5) when passing through said oven (30) is supported by said flows of hot air.

2. The processor (20) according to claim 1, wherein said heating sources (51, 52) have substantially identical operational characteristics, and wherein said means for applying hot air to both sides (6, 7)

of said imaging element (5) generate substantially equal flows (41, 42) at substantially equal air temperatures.

3. The processor according to claim 1 or 2, wherein the housing (31) of the oven (30) further comprises air distribution means (43, 44) consisting of perforated plates, grooved plates or sintered plates.

4. The processor (20) according to any one of the preceding claims, further comprising an entrance unit (80) having means (82) for entering said imaging element (5) into the thermal processor, and an exit unit (90) having means (92) for transporting said imaging element out of the thermal processor.

5. Recording apparatus (1) for photothermographic processing, wherein a thermal processor (20) according to any one of the preceding claims is coupled to an apparatus (10) for exposing said imaging element (5).

6. A method for heat developing an imaging element (5), using a thermal processor (20) according to any one of the claims 1-4.

7. A method for heat developing an imaging element (5) in a thermal processor (20), comprising the steps of moving said imaging element along a predetermined path (35) through an oven (30), and applying hot air to both sides (6, 7) of said imaging element (5), characterised in that said hot air is heated by heating sources with substantially identical operational characteristics, in that said hot air is enforced in substantially equal flows (41, 42) to both sides of said imaging element and in that said flows of hot air are heated to substantially equal air temperatures.

8. The method according to claim 7, further comprising the steps of entering said processor via an entrance unit (80), and transporting said imaging element through an exit unit (90).

9. The method according to any one of the claims 6-8, wherein said substantially equal air temperatures are in the range from 80 to 200 °C, preferably between 90 to 130 °C, more preferably between 100 and 120 °C, even more preferably between 110 °C and 118 ° C.

10. The method according to any one of the claims 6-9, wherein said imaging element 5 is a photothermographic material.

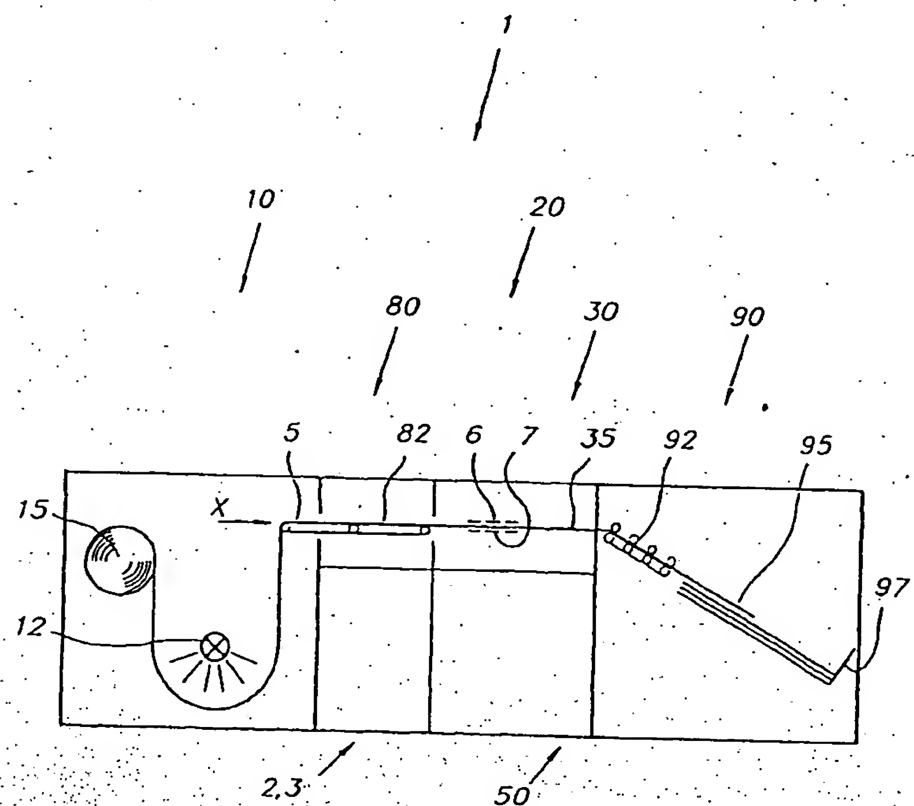

1
10
20
80
30
90
5
82
6
7
35
92
95
15
X
12
97
2,3
50

FIG. 1

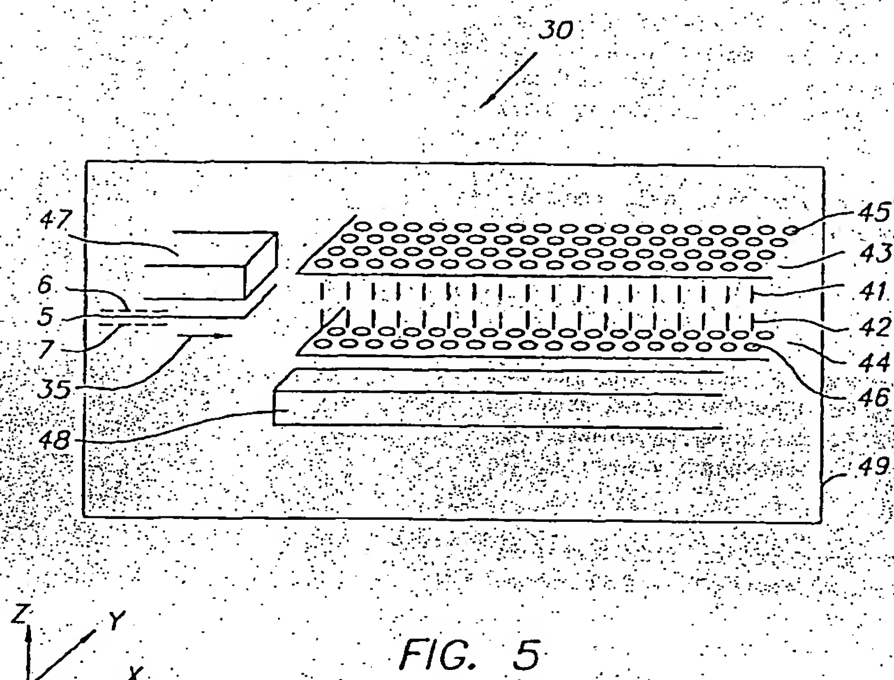

30
47
6
5
7
35
48
45
43
41
42
44
46
49
Z
Y
X

FIG. 5

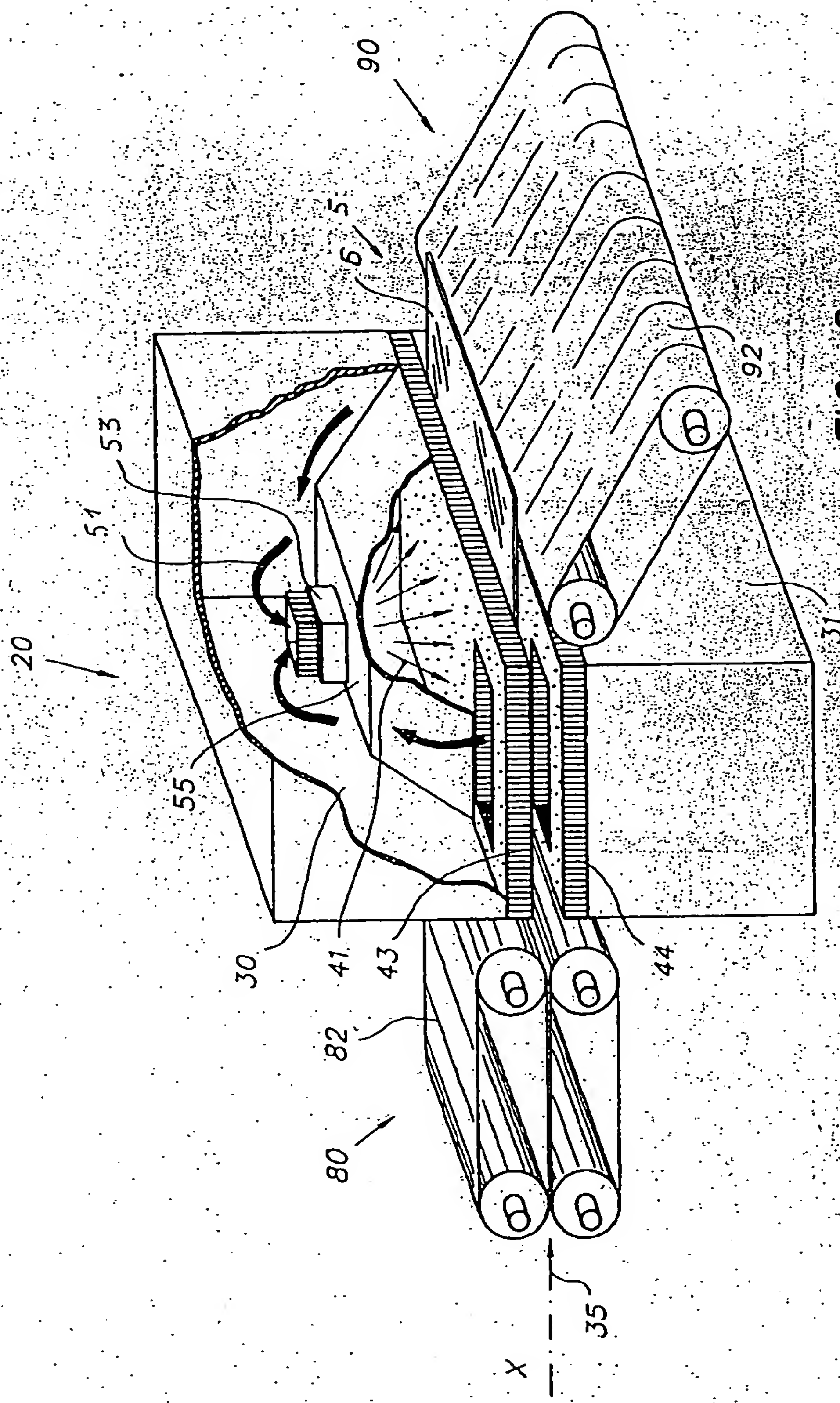



FIG. 2

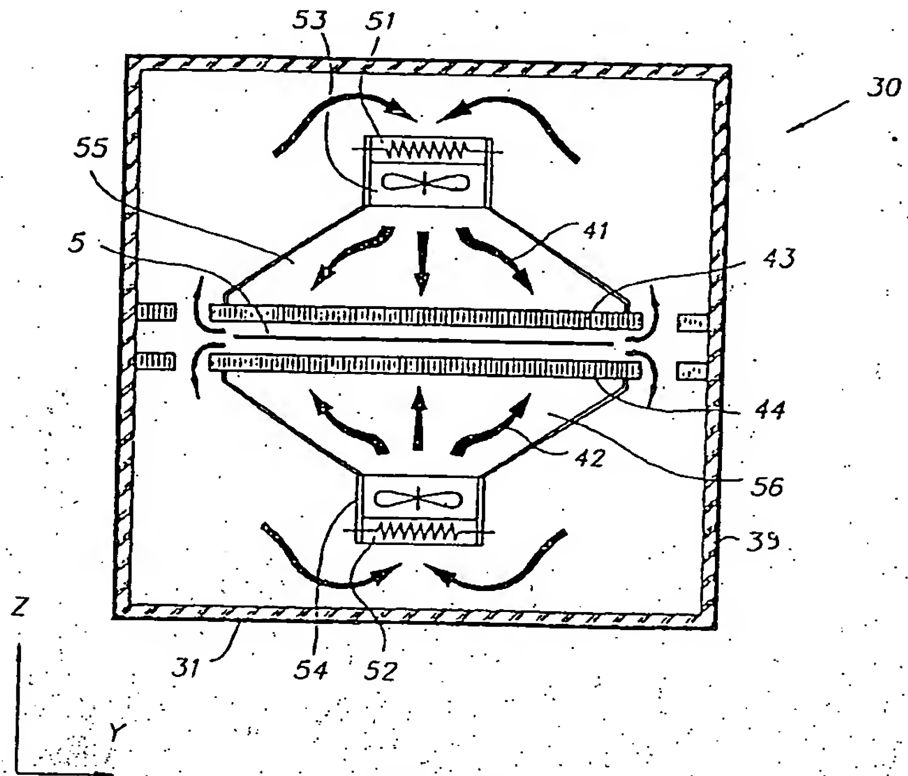

53
51
30
55
41
5
43
44
42
56
39
Z
Y
31
54
52

FIG. 3

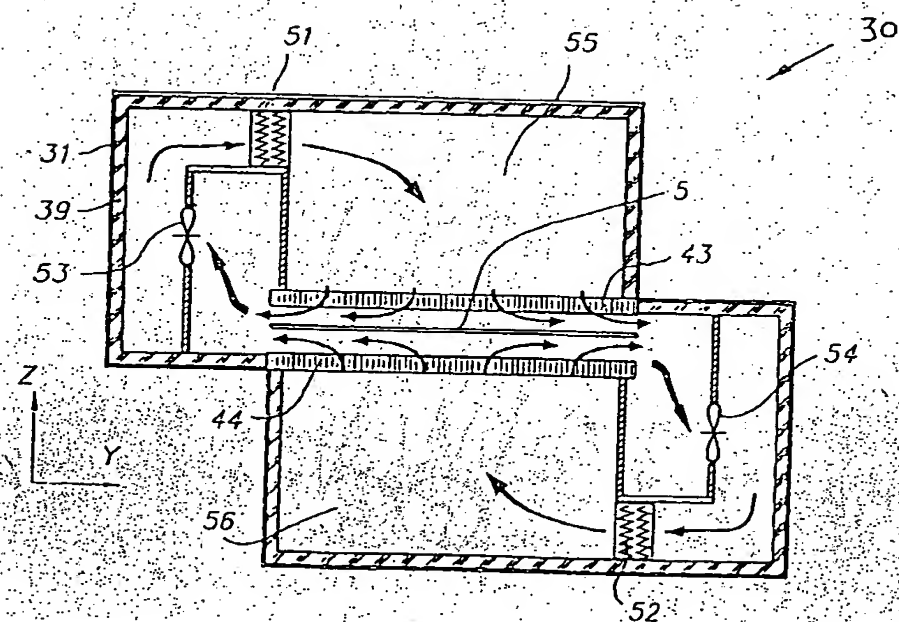
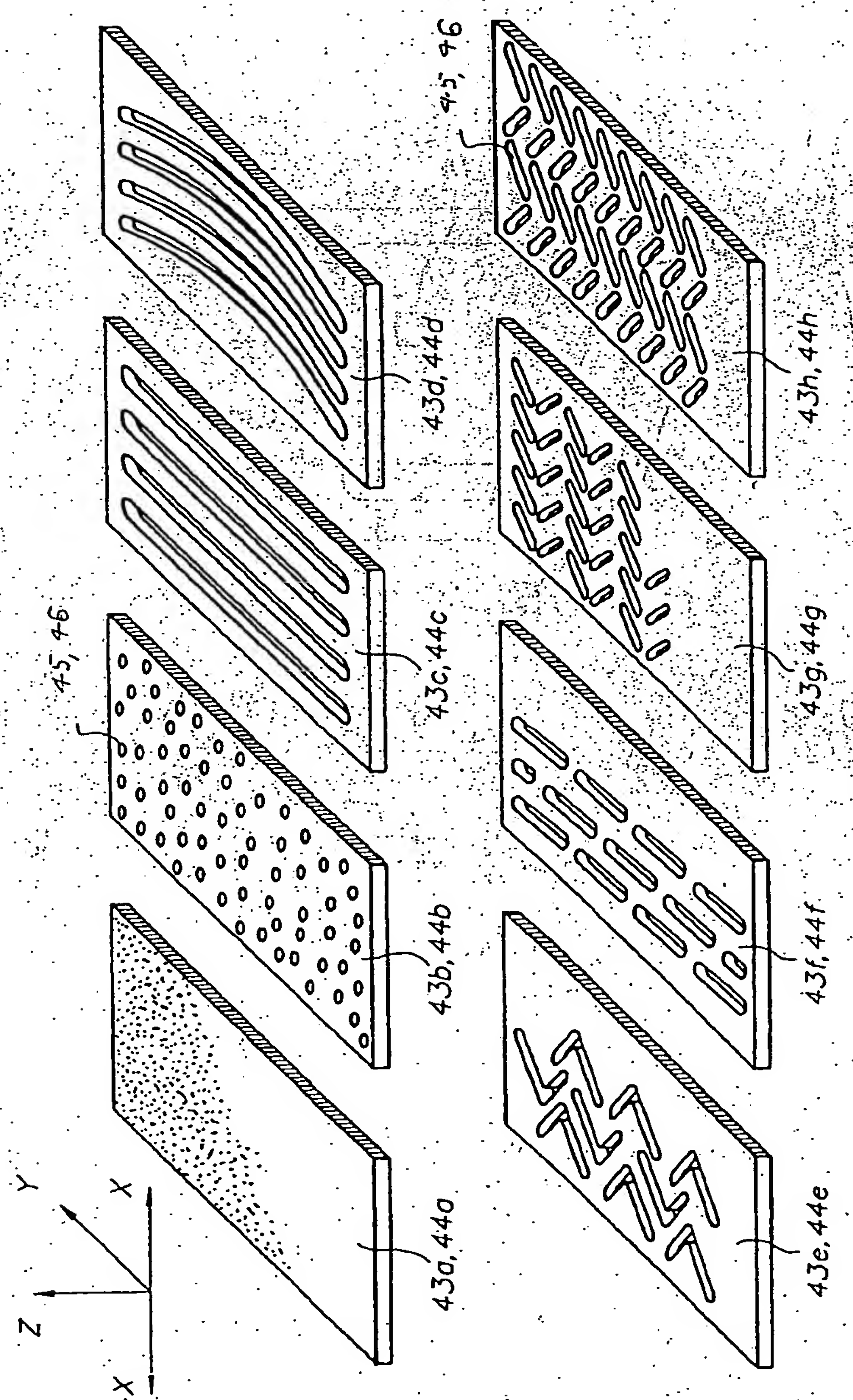

51
55
30
31
39
5
53
43
54
Z
44
Y
56
52

FIG. 4



Y
X
Z
-X
43a, 44a
43b, 44b
45, 46
43c, 44c
43d, 44d
43e, 44e
43f, 44f
43g, 44g
43h, 44h
45, 46


FIG. 6

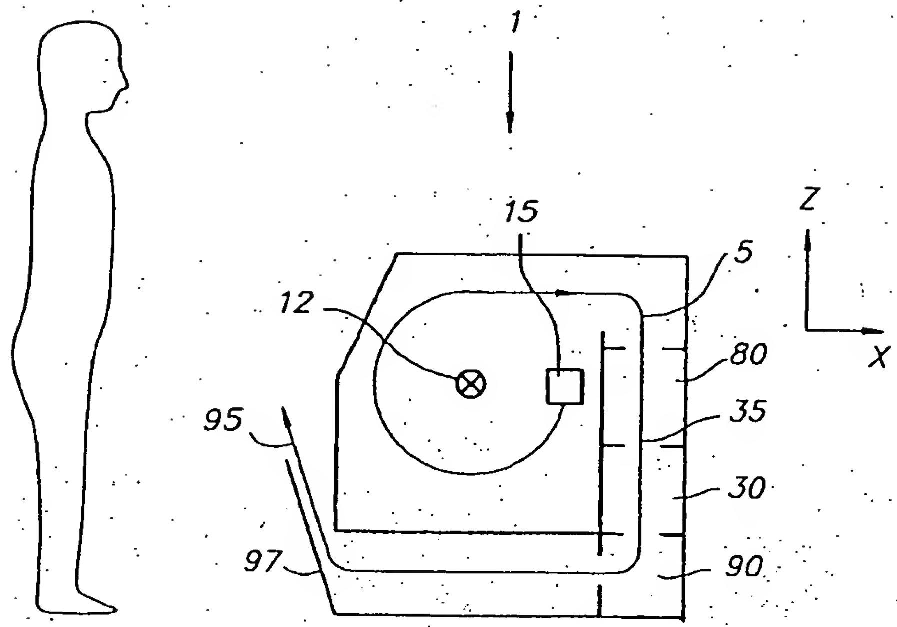



FIG. 7

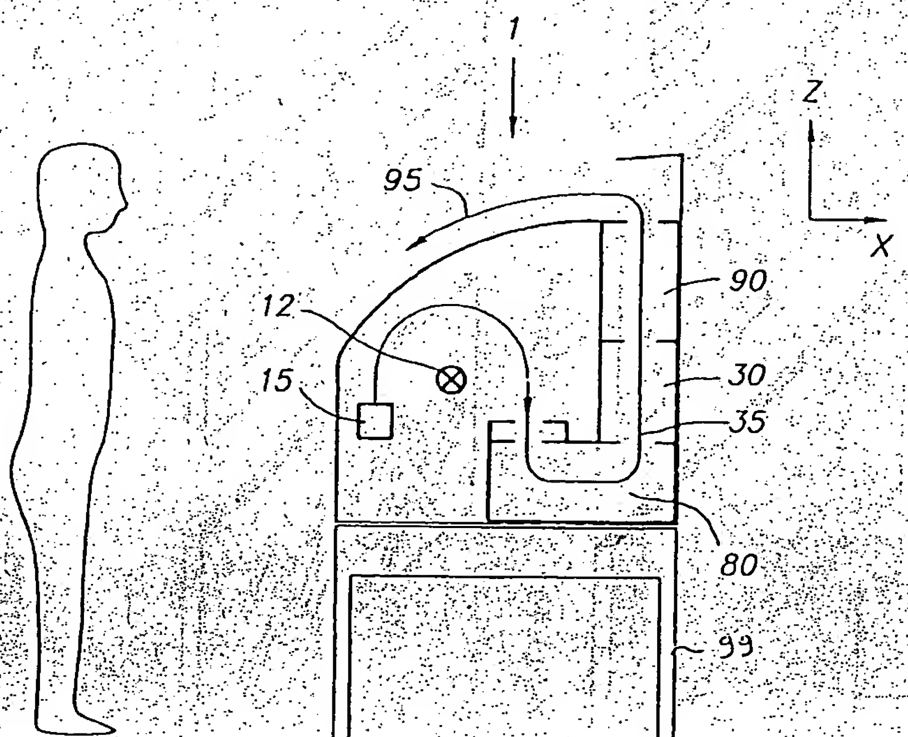



FIG. 8